Focus Graphs - A Proposal for the Visualization of Inter-Community Relationships

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Abstract

The quantity as well as the importance of information exchanged between human communities is increasing as the information society progresses.

This paper proposes the "focus graph" as a technique enabling visualization of the relationships between communities and associated information, so that such may be identified efficiently and comprehensively. The focus graph facilitates arrival at the desired information by linking two kinds of visualization representations; the linked display and the correlation display.

Keywords

visualization of information, information visualization, communities, graph, SNS

1. Introduction

The growth of the information society is tending to support an increase in the strength of bonds between humans and of human communities. Examples of such communities that have recently become more prominent than hitherto include: the in-house networking projects of enterprises, open source software development networks and knowledge community databases. In the case of information sharing within an enterprise, for example, it has been reported that "50% to 75% of the information required in support of business activities was obtained directly between persons" and "more than 80% of in-house information exists only in personal terminals." [1] This situation bears witness to the fact that information exchanged via community networks is increasing both in amount and importance.

Nevertheless, since information is not confined to individual communities but is distributed among various related communities, it becomes necessary to identify the relationships between communities and trace information efficiently through the networks of related communities in order to reach all of the desired information without omission.

2. Traditional Techniques and Issues

Graph representation has hitherto been used as a visualization tool for assisting identification of relationships between communities and related information. Identification of relationships and related information via graphic representation presupposes access to necessary and adequate partial graphs in order to satisfactorily obtain the required information.

An example of traditional techniques dealing with researcher networks may be seen in the study by Dr. Ichise et al. [2] who studied co-authoring and the quoting of papers between authors. Also, an example dealing with the social networking service (SNS) may be seen in the study by Dr. Heer et al. [3] who pioneered interactive graph searches. However, traditional techniques are not always effective and for the following reasons: If a search is started from general information in a top-down type approach, it is possible to understand the overall image but details such as the finer points of relationships between individual communities cannot be known. Even when a part is expanded, it is not possible to identify inter-community relationships efficiently because the expansion includes unnecessary nodes and links (**Fig. 1**).

On the other hand, if a search is started from the local information in a bottom-up type approach, the details in the proximity of specific points may be more understandable but the overall relationships become unclear and all-inclusive identification is impossible (**Fig. 2**). In short, traditional techniques do not offer a means of obtaining the required partial graphs either all-inclusively or efficiently.

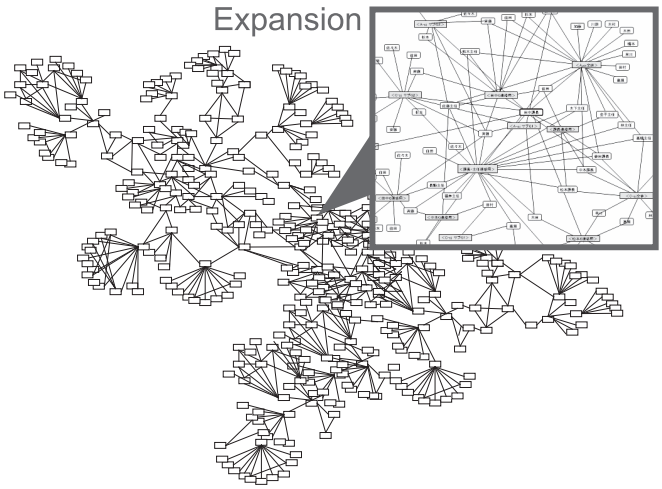

Fig. 1 Graph search from general information.

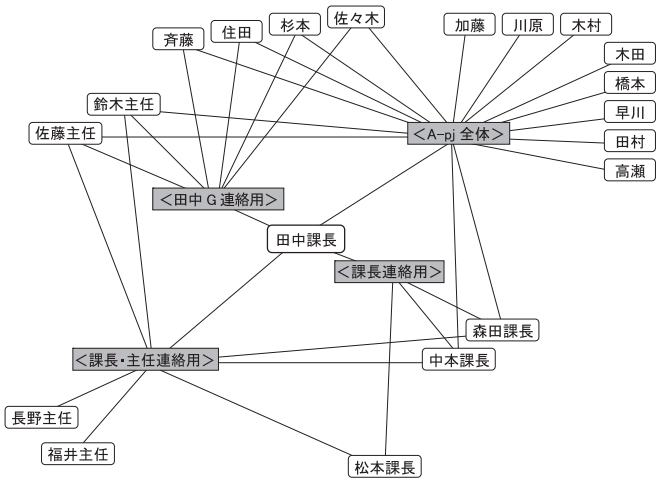

Fig. 2 Graph search from local information.

3. Proposed Focus Graph

In the present paper, we suggest using the "focus graph" as a technique for solving the issues described above.

3.1 Outline of the Focus Graph

The focus graph technique performs a graph search by switching two kinds of visualization expressions, the "linked display" that offers detailed information and the "correlation display" that offers general information related to the point of interest in order to enable efficient, all-inclusive, arbitrarily timed graph operations. The linked display is based on the traditional graphical representation. It features the use of two types of nodes; human nodes and community nodes and connects only between different types of nodes. However, it is not capable of offering the required partial graphs as is the traditional technique. To enable an efficient, all-inclusive graph search, the proposed technique prepares the general information of the linked display as a separate view and operates the general information based directly on this input. The means for displaying and operating the general information is the correlation display. This displays those parts that are relevant to a point of interest in the linked display and represents the relationships with the information of interest as well as other information with high accuracy and visual enhancement. By expanding or reducing the correlation display it becomes possible to eliminate any unnecessary parts and to effectively enlarge the proximal information in an efficient manner. Switching the linked and correlation displays arbitrarily makes it possible to view detailed relationship information as required (**Fig. 3**).

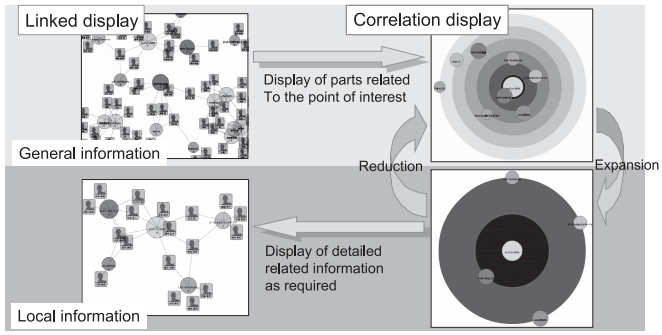

Fig. 3 Outline of focus graph.

The following sections describe the visualization representations of the two displays in detail.

3.2 Linked Display

The Linked display is a network-type graph composed of nodes and links (**Fig. 4**). The nodes include human nodes and community nodes, and the links represent the affiliation relationships of persons and communities. The nodes are arranged using the Fruchterman-Reingold (FR) model [4] , which is a kind of spring model featuring a visually natural arrangement and efficient calculations.

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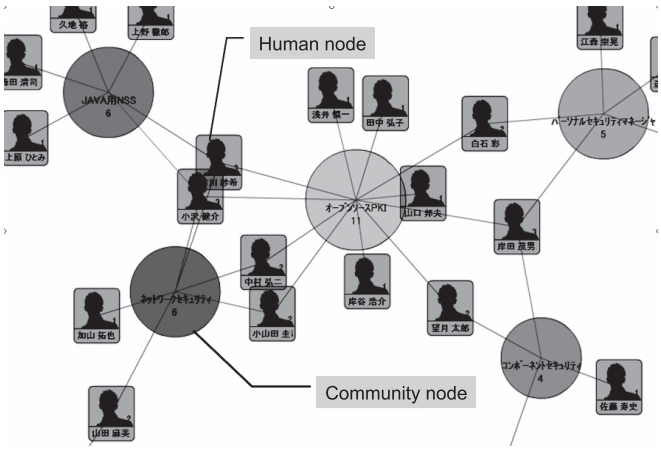

Fig. 4 Linked display.

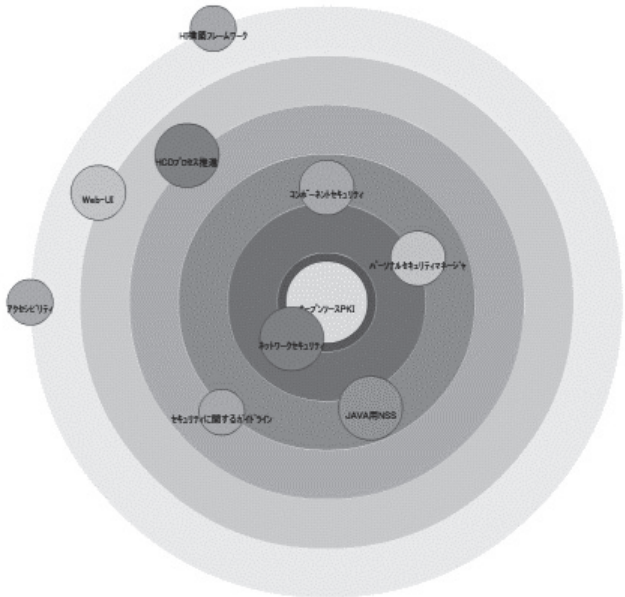

Fig. 5 Correlation view.

3.3 Correlation Display

The correlation display is an easy-to-understand representation that enhances correlations between the nodes of interest and other nodes (nodes of no interest) (**Fig. 5**). It places the nodes of interest at the center of a polar coordinate system and the other nodes are arranged around the node of interest. The nodes are placed so that the relevance between each pair of nodes is reflected by the radial length in the case of an adjacent node of interest and a node of no interest, or by the central angle in the case of adjacent nodes of no interest. The relevance ratio, (s), is obtained by the formula (1) below, where (n) is the number of the shortest approach paths between the nodes and (l) is the length of the shortest path between them.

$$s = m \cdot \frac{n}{l} \qquad (m = \text{constant}) \qquad (1)$$

This indicates that, with the linked display, the relevance is stronger in the cases that the logical distance of the shortest path length is shorter, and also the number of shortest approach ways that means that the number of commonly related elements is larger. The nodes that are not a focus of interest are arranged by calculating each radial length and each deviation angle independently. The radial length is determined so that the relevance ratio between the node of interest and each of the other nodes is inversely proportional and the deviation angle is determined by applying the FR model in an environment in which the node movement range is subject to circumferential constraints.

3.4 Operation of the Focus Graph

The focus graph performs different operations on the linked display and correlation display. In the case of the linked display, a graph search is performed using the “deployment,” “encapsulation” and “hiding” operations. For the correlation display, a graph search is performed using the “expansion” and “reduction” operations that change the area displayed around the node of interest and the “node of interest changing” operation that upgrades a selected node of no interest into the graph of a new node of interest.

The focus graph switches the linked display to the correlation display when the general information of the graph is required and the correlation display to the linked display when detailed information is required. The correlation display obtained by switching from the linked display is the display that places the node of interest in the linked display at the center. The linked display obtained by switching from the correlation display is the display of the deployment of the node that was displayed in the correlation display.

4. Example of Focus Graph Operation

This section describes an example of focus graph operation as shown in **Fig. 6** , in which the path/connection to a person

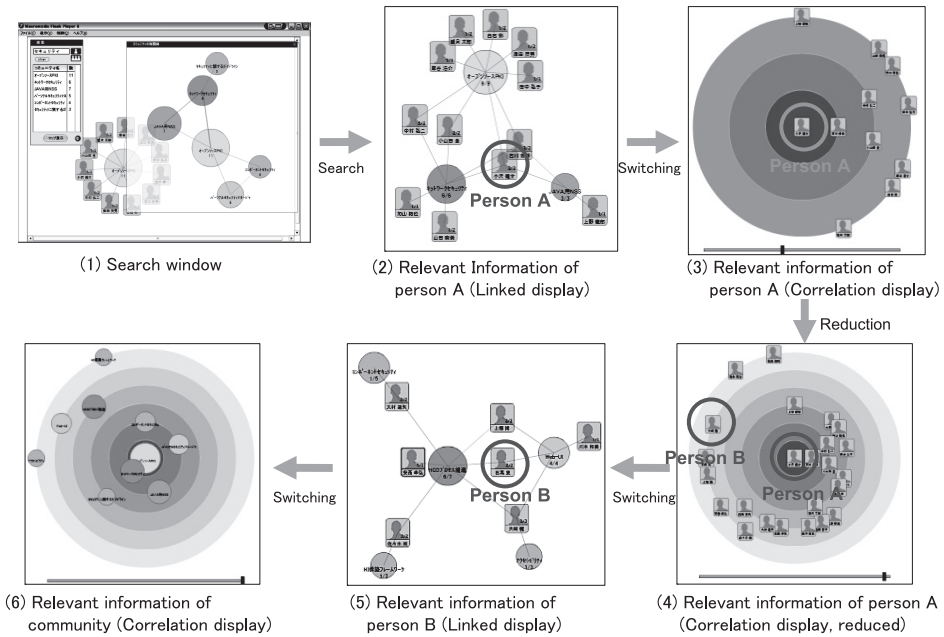

Fig. 6 Examples of focus graph operations.

possessing desired information is searched. It assumes that the operator is person A, who wants to find the human link (through relevant persons and communities) that will lead person A to the knowledgeable person B.

First, the relevance information of person A is searched and displayed. This example assumes that the display begins with the linked display (Fig. 6 (1) (2)). Next, in order to obtain the personal relevance information centered on person A, the view is switched to the correlation display that sets person A as the node of interest (Fig. 6 (3)). In this display, the persons affiliating to the same community as person A are displayed near the center. Then, since person B is not currently displayed, the viewed display is expanded (Fig. 6 (4)). In the current condition, the persons linking persons A and B are displayed in concentric circles. Use of the correlation display has made it possible to effectively obtain the partial graph of the human link from person A to person B without the need to deploy or hide each node. The resulting correlation display is all-inclusive because it is free from omission of deployment of the necessary nodes.

Next, when the search is advanced in order to observe the relevance of person B with other persons in detail, the display can be switched to the correlation display centered on person B. When detailed relevance information such as the communities to which person B affiliates is required, the view can be switched to the linked display (Fig. 6 (5)).

The current example deals with human search operations, but searches of communities are also possible by switching the linked and correlation displays in the same manner (Fig. 6 (6)).

5. Conclusion

In the above, we propose the focus graph as a technique for the visualization of inter-community relationships. The focus graph facilitates arrival at the desired information using a linked display that shows detailed information or by a correlation display that shows general information related to a specific point. The proposed technique presents the relevant information in an easily understood form with the correlation display featuring an arrangement of nodes of no interest on the polar coordinates centered on the node of interest. In the future, we will apply this technique to an increased number of cases and conduct suitable user testing procedures in order to verify its effectiveness.

*As the products introduced in this paper are mainly provided for the domestic market, some figures feature explanations by the Japanese Language.

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